Fig. 1
PRIOR ART
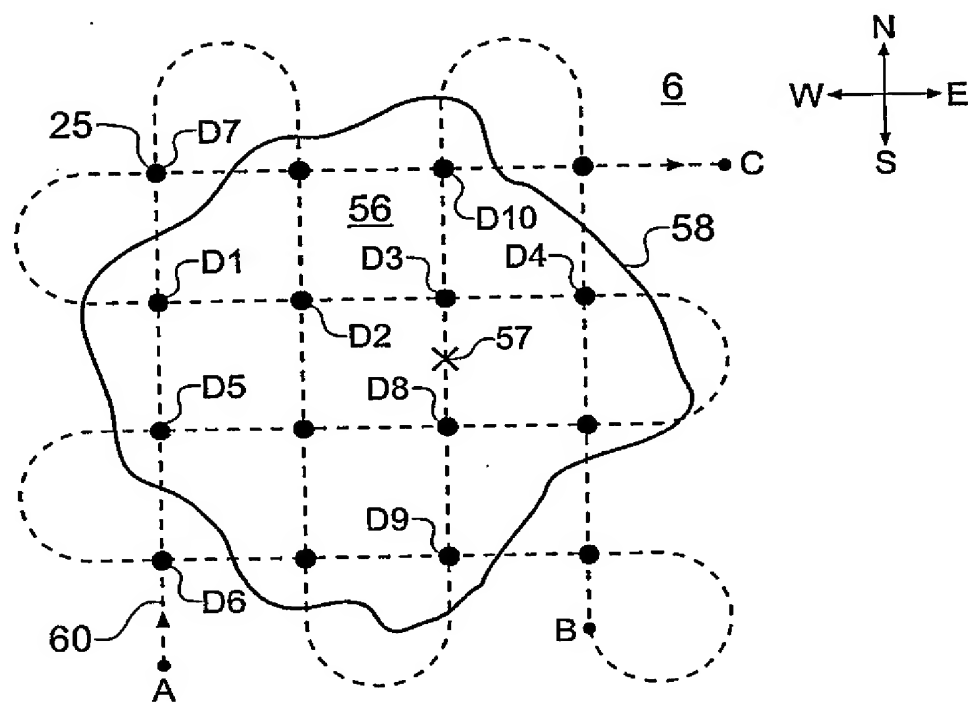
Fig. 2
PRIOR ART

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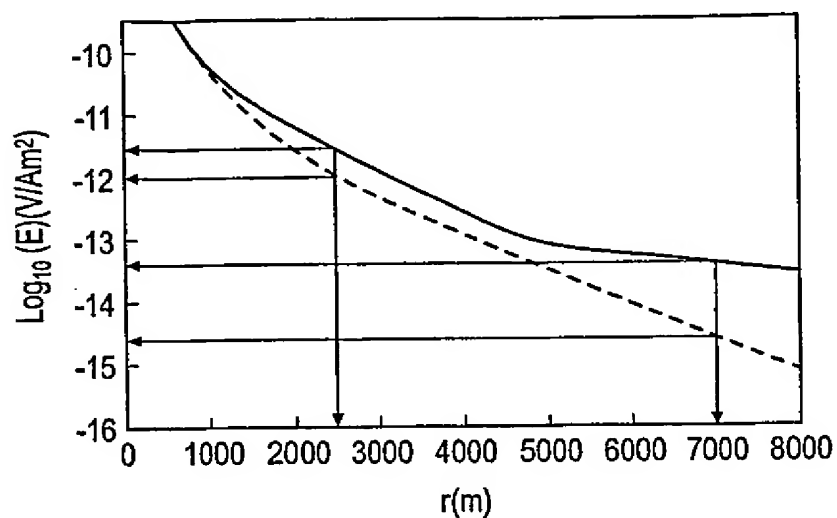

Fig. 3A
PRIOR ART
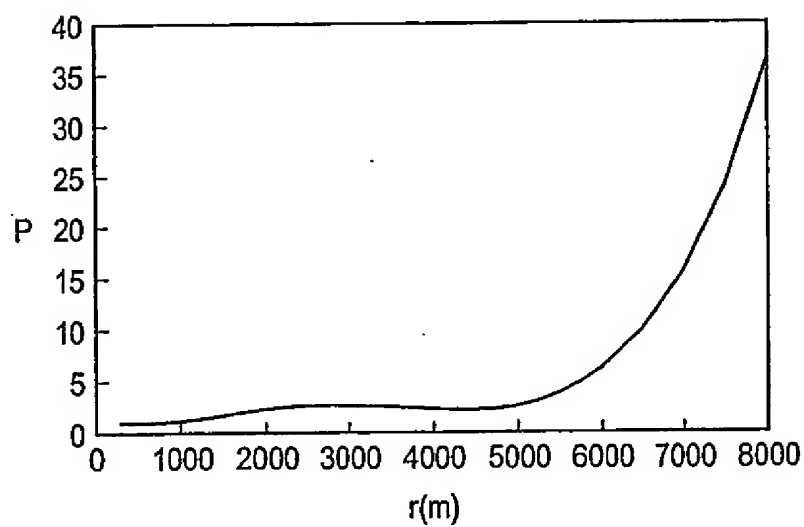

Fig. 3B
PRIOR ART
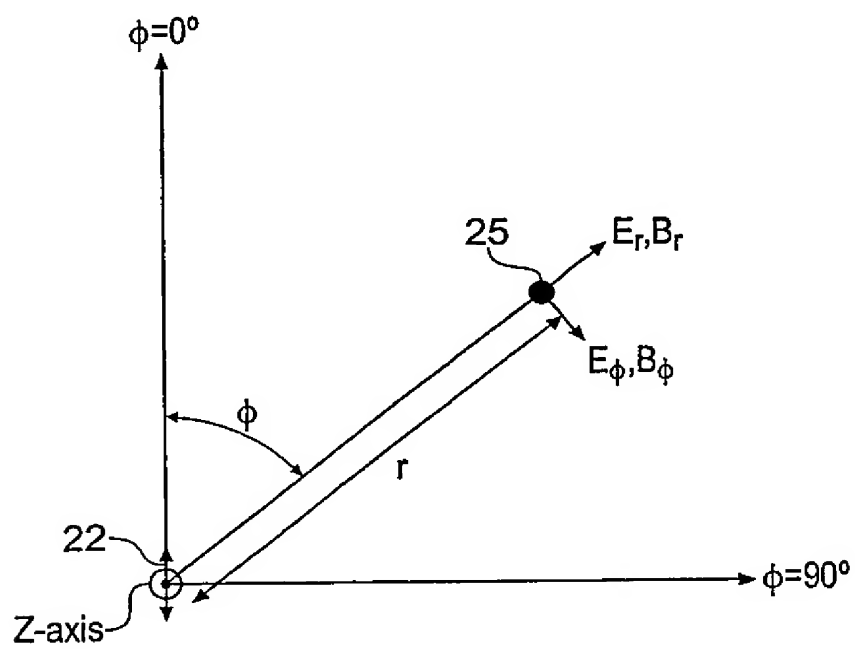
Fig. 4

$$E_r = \frac{P\rho_0\cos\phi}{4\pi}\int_0^\infty \Big[\Big(-\underbrace{\beta_0\frac{kJ_0(kr)-\frac{J_1(kr)}{r}}{1+R_L^{TM}e^{-2\beta_0 h}}}_{TM}+\underbrace{i\frac{\omega\mu_0 J_1(kr)}{r\beta_0\rho_0(1-R_A^{TE}R_L^{TE}e^{-2\beta_0 h})}}_{TE}\Big)e^{-\beta_0|z-z'|}+$$

$$\Big(\underbrace{\beta_0\frac{kJ_0(kr)-\frac{J_1(kr)}{r}}{1+R_L^{TM}e^{-2\beta_0 h}}R_L^{TM}}_{TM}+\underbrace{i\frac{\omega\mu_0 J_1(kr)}{r\beta_0\rho_0(1-R_A^{TE}R_L^{TE}e^{-2\beta_0 h})}R_L^{TE}}_{TE}\Big)e^{-\beta_0(z+z')}+$$

$$\Big(-\underbrace{\beta_0\frac{kJ_0(kr)-\frac{J_1(kr)}{r}}{1+R_L^{TM}e^{-2\beta_0 h}}}_{TM}+\underbrace{i\frac{\omega\mu_0 J_1(kr)}{r\beta_0\rho_0(1-R_A^{TE}R_L^{TE}e^{-2\beta_0 h})}R_A^{TE}}_{TE}\Big)e^{\beta_0(z+z'-2h)}+$$

$$\Big(\underbrace{\beta_0\frac{kJ_0(kr)-\frac{J_1(kr)}{r}}{1+R_L^{TM}e^{-2\beta_0 h}}R_L^{TM}}_{TM}+\underbrace{i\frac{\omega\mu_0 J_1(kr)}{r\beta_0\rho_0(1-R_A^{TE}R_L^{TE}e^{-2\beta_0 h})}R_A^{TE}R_L^{TE}}_{TE}\Big)e^{\beta_0(|z-z'|-2h)}\Big]dk$$

Fig. 5A (EQ.1)

$$E_\phi = \frac{P\rho_0\sin\phi}{4\pi}\int_0^\infty \Big[\Big(\underbrace{\frac{\beta_0 J_1(kr)}{r(1+R_L^{TM}e^{-2\beta_0 h})}}_{TM}-\underbrace{i\omega\mu_0\frac{kJ_0(kr)-\frac{J_1(kr)}{r}}{\beta_0\rho_0(1-R_A^{TE}R_L^{TE}e^{-2\beta_0 h})}}_{TE}\Big)e^{-\beta_0|z-z'|}+$$

$$\Big(-\underbrace{\frac{\beta_0 J_1(kr)}{r(1+R_L^{TM}e^{-2\beta_0 h})}R_L^{TM}}_{TM}-\underbrace{i\omega\mu_0\sigma_0\frac{kJ_0(kr)-\frac{J_1(kr)}{r}}{\beta_0(1-R_A^{TE}R_L^{TE}e^{-2\beta_0 h})}R_L^{TE}}_{TE}\Big)e^{-\beta_0(z+z')}+$$

$$\Big(\underbrace{\frac{\beta_0 J_1(kr)}{r(1+R_L^{TM}e^{-2\beta_0 h})}}_{TM}-\underbrace{i\omega\mu_0\frac{kJ_0(kr)-\frac{J_1(kr)}{r}}{\beta_0\rho_0(1-R_A^{TE}R_L^{TE}e^{-2\beta_0 h})}R_A^{TE}}_{TE}\Big)e^{\beta_0(z+z'-2h)}+$$

$$\Big(-\underbrace{\frac{\beta_0 J_1(kr)}{r(1+R_L^{TM}e^{-2\beta_0 h})}R_L^{TM}}_{TM}-\underbrace{i\omega\mu_0\frac{kJ_0(kr)-\frac{J_1(kr)}{r}}{\beta_0\rho_0(1-R_A^{TE}R_L^{TE}e^{-2\beta_0 h})}R_A^{TE}R_L^{TE}}_{TE}\Big)e^{\beta_0(|z-z'|-2h)}\Big]dk$$

Fig. 5B (EQ.2)

$$E_z = \frac{P\rho_0\cos\phi}{4\pi}\int_0^\infty \frac{k^2 J_1(kr)}{1+R_L^{TM}e^{-2\beta_0 h}}\Big[\mp e^{-\beta_0|z-z'|}-R_L^{TM}e^{-\beta_0(z+z')}-e^{\beta_0(z+z'-2h)}\mp$$

$$R_L^{TM}e^{\beta_0(|z-z'|-2h)}\Big]dk$$

Fig. 5C (EQ.3)

$$B_r = \frac{\mu_0 P \sin\phi}{4\pi} \int_0^\infty \Big[\pm \Big(\underbrace{\frac{J_1(kr)}{r(1+R_L^{TM}e^{-2\beta_0 h})}}_{TM} + \underbrace{\frac{kJ_0(kr) - \frac{J_1(kr)}{r}}{1 - R_A^{TE}R_L^{TE}e^{-2\beta_0 h}}}_{TE} \Big) e^{-\beta_0|z-z'|} +$$

$$\Big(\underbrace{\frac{J_1(kr))}{r(1+R_L^{TM}e^{-2\beta_0 h})}R_L^{TM}}_{TM} - \underbrace{\frac{kJ_0(kr) - \frac{J_1(kr)}{r}}{1 - R_A^{TE}R_L^{TE}e^{-2\beta_0 h}}R_L^{TE}}_{TE} \Big) e^{-\beta_0(z+z')} +$$

$$\Big(\underbrace{\frac{J_1(kr)}{r(1+R_L^{TM}e^{-2\beta_0 h})}}_{TM} + \underbrace{\frac{kJ_0(kr) - \frac{J_1(kr)}{r}}{1 - R_A^{TE}R_L^{TE}e^{-2\beta_0 h}}R_A^{TE}}_{TE} \Big) e^{\beta_0(z+z'-2h)} \pm$$

$$\Big(\underbrace{\frac{J_1(kr)}{r(1+R_L^{TM}e^{-2\beta_0 h})}R_L^{TM}}_{TM} - \underbrace{\frac{kJ_0(kr) - \frac{J_1(kr)}{r}}{1 - R_A^{TE}R_L^{TE}e^{-2\beta_0 h}}R_A^{TE}R_L^{TE}}_{TE} \Big) e^{\beta_0\left(|z-z'|-2h\right)} \Big] dk$$

Fig. 5D (EQ.4)

$$B_\phi = \frac{\mu_0 P \cos\phi}{4\pi} \int_0^\infty \Big[\pm \Big(\underbrace{\frac{kJ_0(kr) - \frac{J_1(kr)}{r}}{1+R_L^{TM}e^{-2\beta_0 h}}}_{TM} + \underbrace{\frac{J_1(kr)}{r(1 - R_A^{TE}R_L^{TE}e^{-2\beta_0 h})}}_{TE} \Big) e^{-\beta_0|z-z'|} +$$

$$\Big(\underbrace{\frac{kJ_0(kr) - \frac{J_1(kr)}{r}}{1+R_L^{TM}e^{-2\beta_0 h}}R_L^{TM}}_{TM} - \underbrace{\frac{J_1(kr)}{r(1 - R_A^{TE}R_L^{TE}e^{-2\beta_0 h})}R_L^{TE}}_{TE} \Big) e^{-\beta_0(z+z')} +$$

$$\Big(\underbrace{\frac{kJ_0(kr) - \frac{J_1(kr)}{r}}{1+R_L^{TM}e^{-2\beta_0 h}}}_{TM} + \underbrace{\frac{J_1(kr)}{r(1 - R_A^{TE}R_L^{TE}e^{-2\beta_0 h})}R_A^{TE}}_{TE} \Big) e^{\beta_0(z+z'-2h)} \pm$$

$$\Big(\underbrace{\frac{kJ_0(kr) - \frac{J_1(kr)}{r}}{1+R_L^{TM}e^{-2\beta_0 h}}R_L^{TM}}_{TM} - \underbrace{\frac{J_1(kr)}{r(1 - R_A^{TE}R_L^{TE}e^{-2\beta_0 h})}R_A^{TE}R_L^{TE}}_{TE} \Big) e^{\beta_0\left(|z-z'|-2h\right)} \Big] dk$$

Fig. 5E (EQ.5)

$$B_z = \frac{\mu_0 P \sin\phi}{4\pi} \int_0^\infty \frac{k^2 J_1(kr)}{\beta_0(1 - R_A^{TE}R_L^{TE}e^{-2\beta_0 h})} \Big[e^{-\beta_0|z-z'|} + R_L^{TE}e^{-\beta_0(z+z')} + R_A^{TE}e^{\beta_0(z+z'-2h)} +$$

$$R_A^{TE}R_L^{TE}e^{\beta_0\left(|z-z'|-2h\right)} \Big] dk$$

Fig. 5F (EQ.6)

$$\frac{\partial E_r}{\partial z} - i\omega B_\phi = -\frac{P\rho_0 \cos\phi}{4\pi} \int_0^\infty k^2 \frac{kJ_0(kr) - \frac{J_1(kr)}{r}}{1 + R_L^{TM} e^{-2\beta_0 h}} \left[\pm e^{-\beta_0|z-z'|} + R_L^{TM} e^{-\beta_0(z+z')} + e^{\beta_0(z+z'-2h)} \pm \right.$$
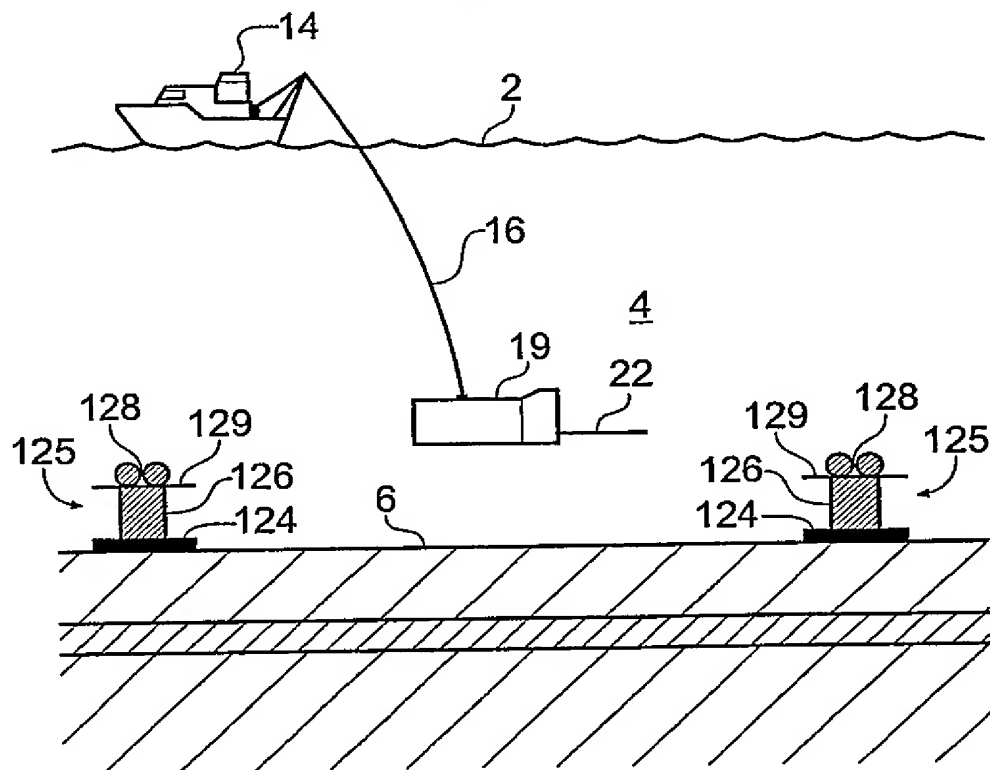$$\left. R_L^{TM} e^{\beta_0(|z-z'|-2h)} \right] dk$$

Fig. 5G (EQ.7)

$$\frac{\partial E_\phi}{\partial z} + i\omega B_r = \frac{P\rho_0 \sin\phi}{4\pi r} \int_0^\infty \frac{k^2 J_1(kr)}{1 + R_L^{TM} e^{-2\beta_0 h}} \left[\pm e^{-\beta_0|z-z'|} + R_L^{TM} e^{-\beta_0(z+z')} + e^{\beta_0(z+z'-2h)} \pm \right.$$
$$\left. R_L^{TM} e^{\beta_0(|z-z'|-2h)} \right] dk$$

Fig. 5H (EQ.8)

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Fig. 6A
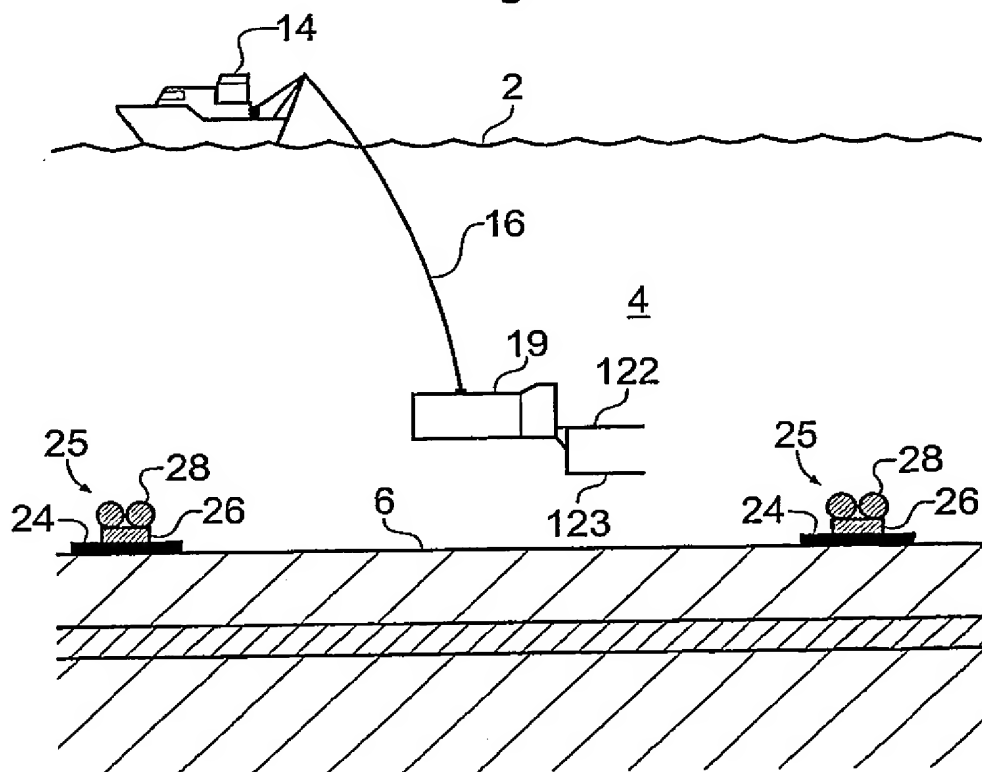
Fig. 6B
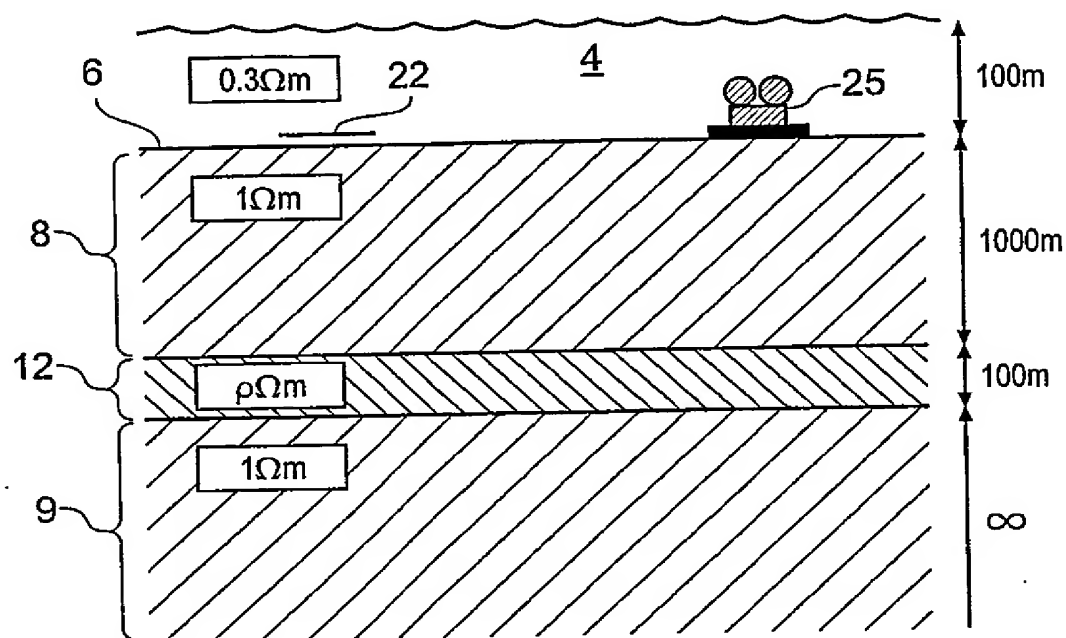
9/17
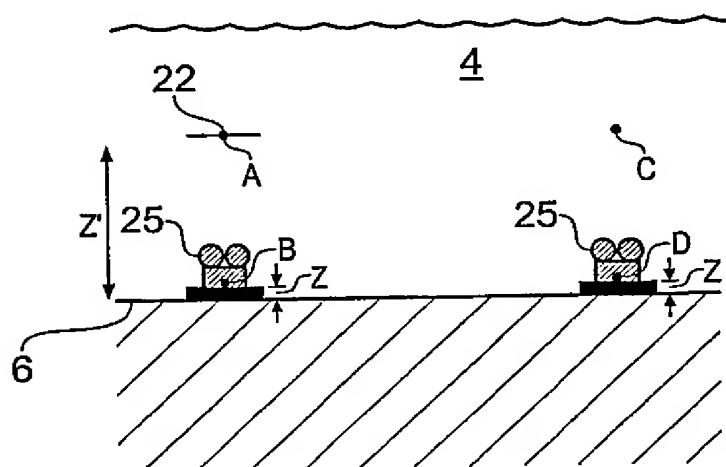
Fig. 7A
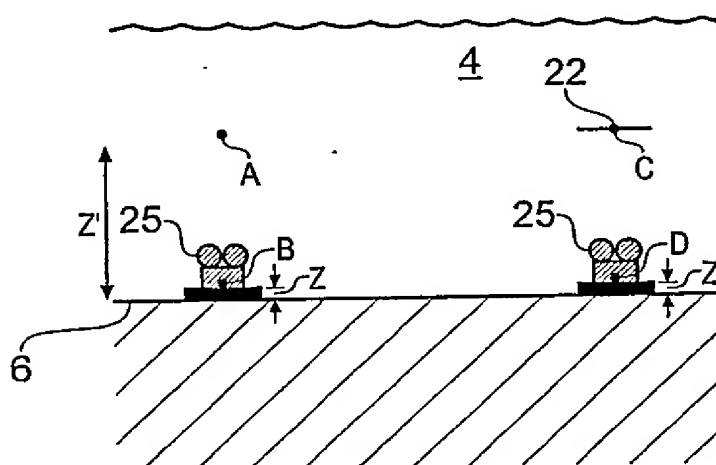
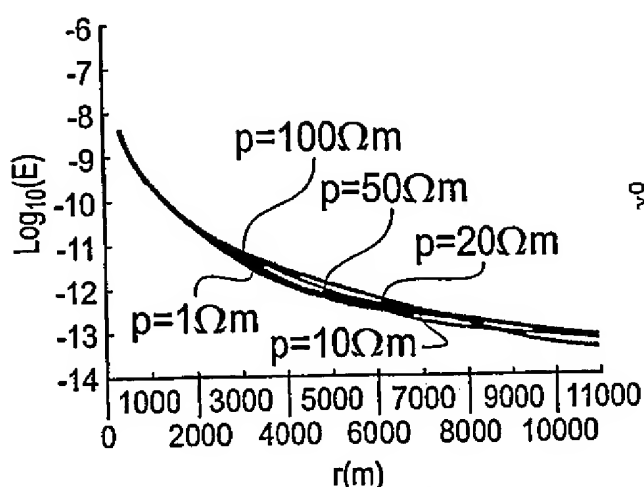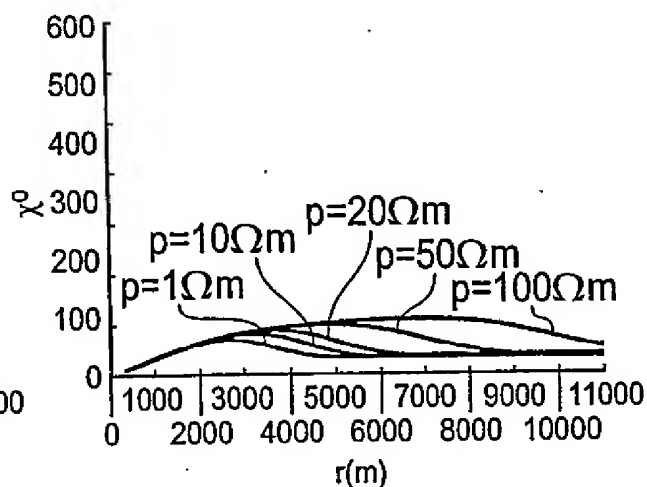Fig. 7B
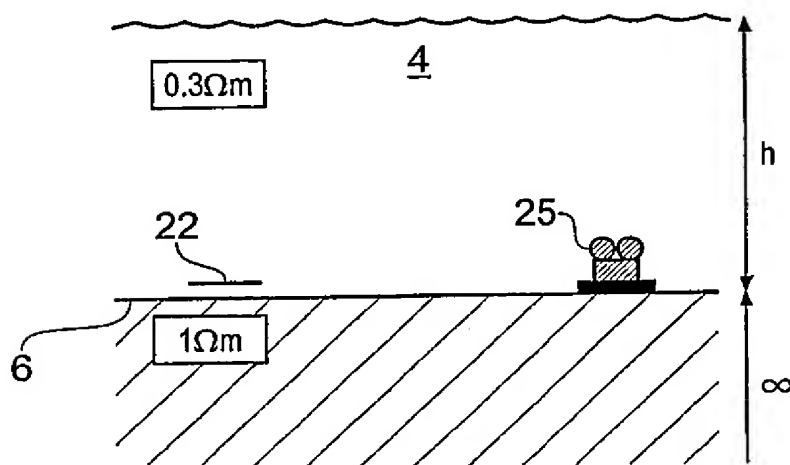
Fig. 8
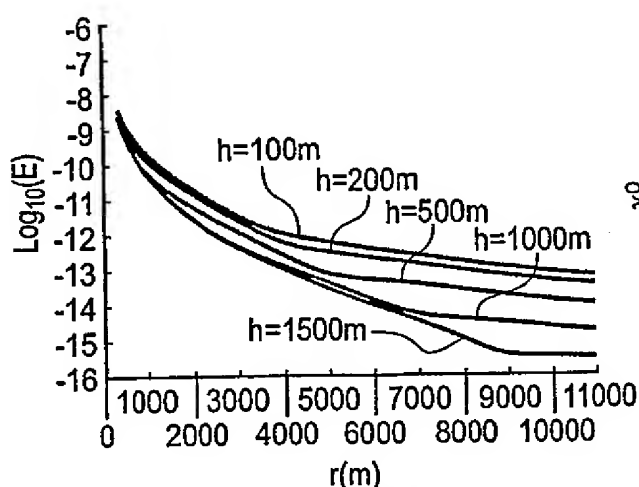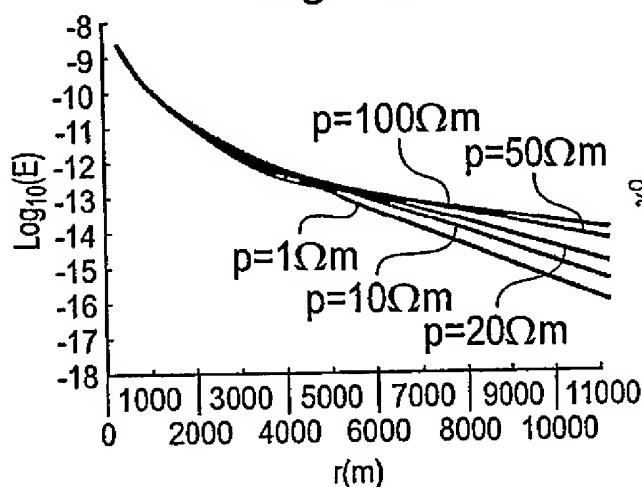
Fig. 9A
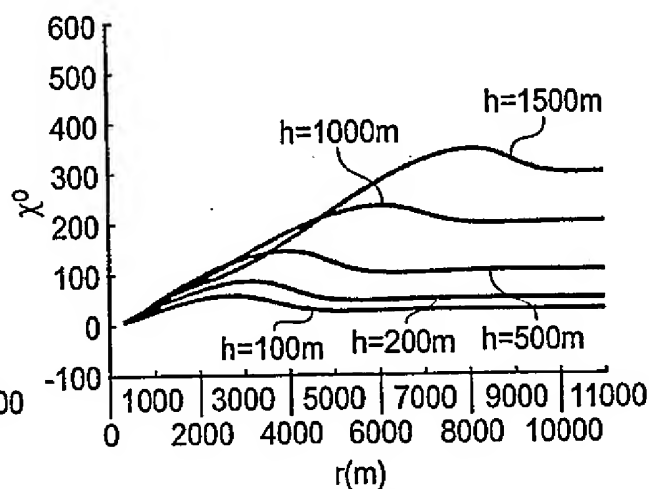
Fig. 9B
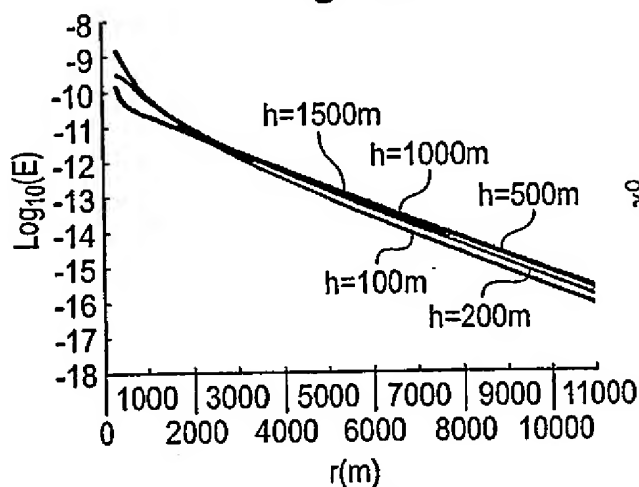
Fig. 10A
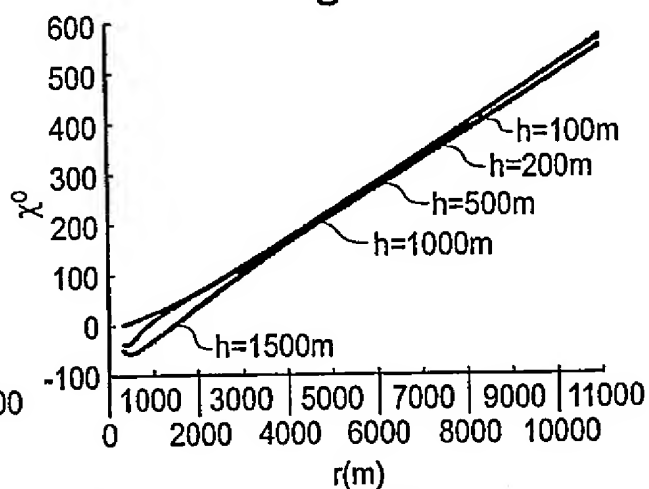
Fig. 10B
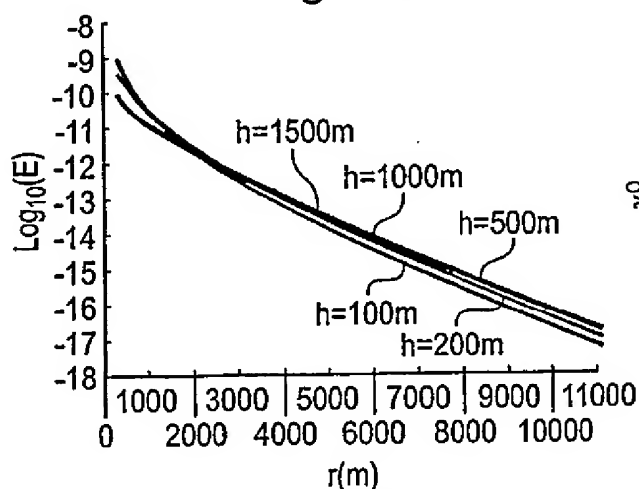
Fig. 10C
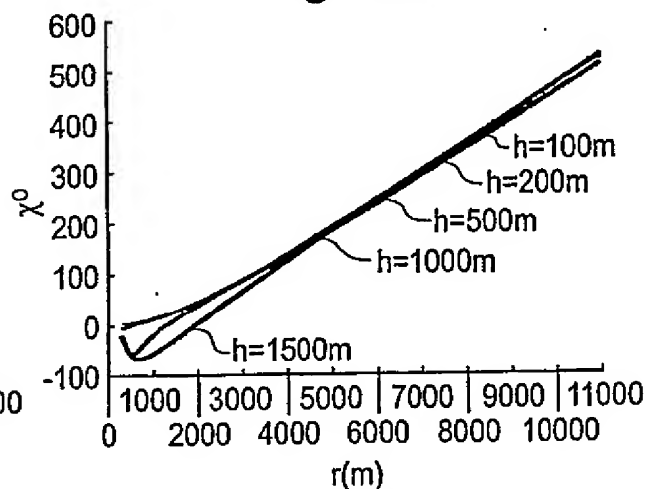
Fig. 10D

Fig. 11

Fig. 12A

Fig. 12B

Fig. 13A

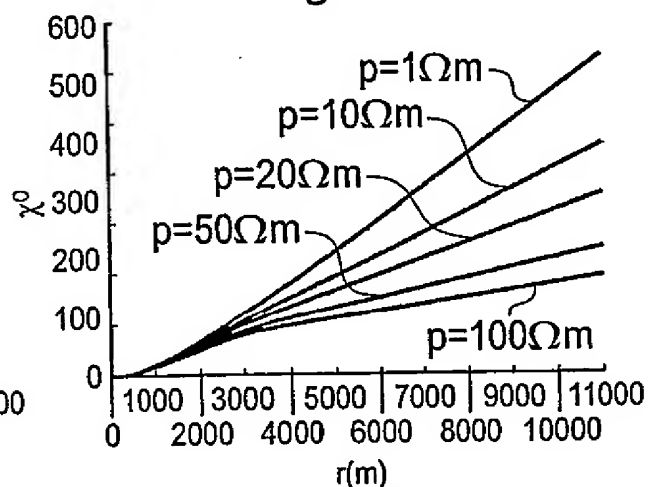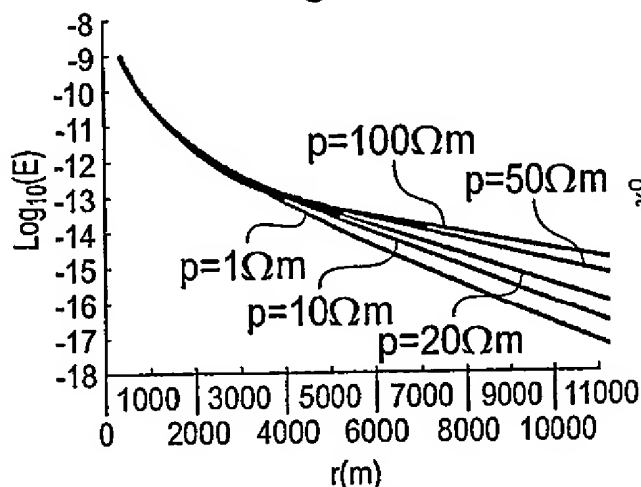Fig. 13B

Fig. 13C

Fig. 13D

Fig. 14A

Fig. 14B

Anomaly

Fig. 14C

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0.3Ωm

_4_

∞

6   22   25

1Ωm

8

1000m

12   100Ωm

100m

1Ωm

9

∞

Fig. 15A

0.3Ωm

_4_

∞

6   22   25

10   1Ωm

400m

13   5Ωm

1000m

15   10Ωm

∞
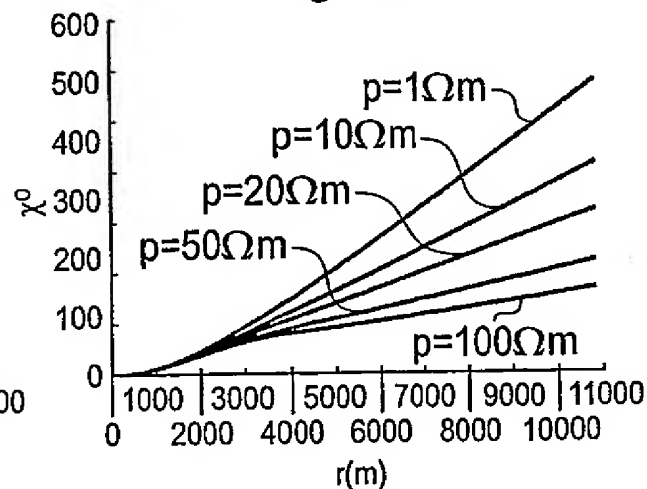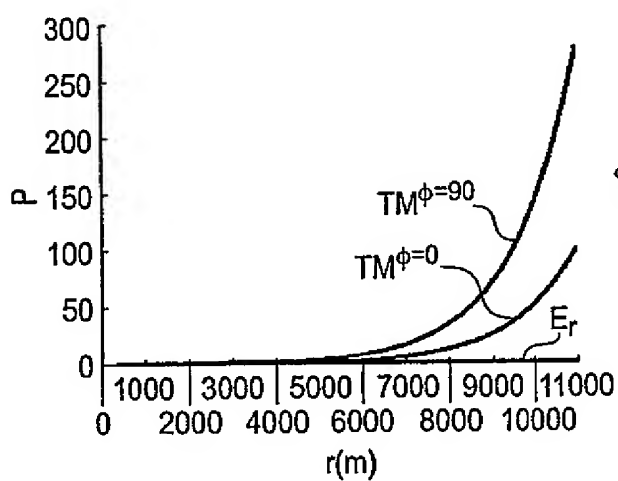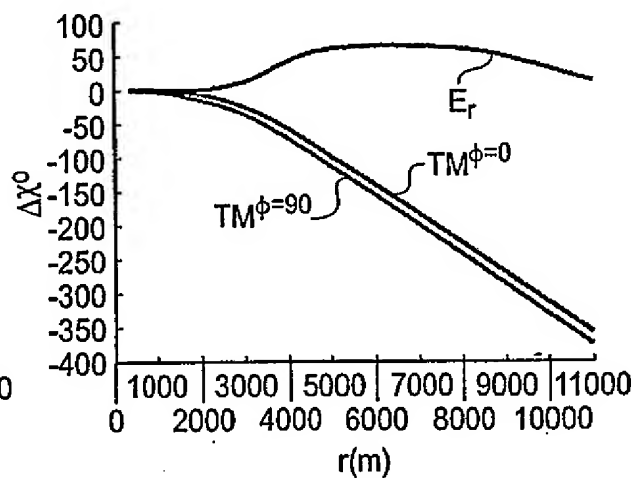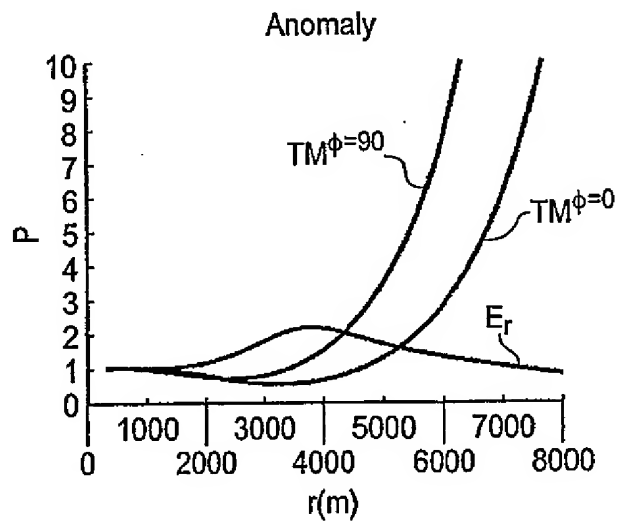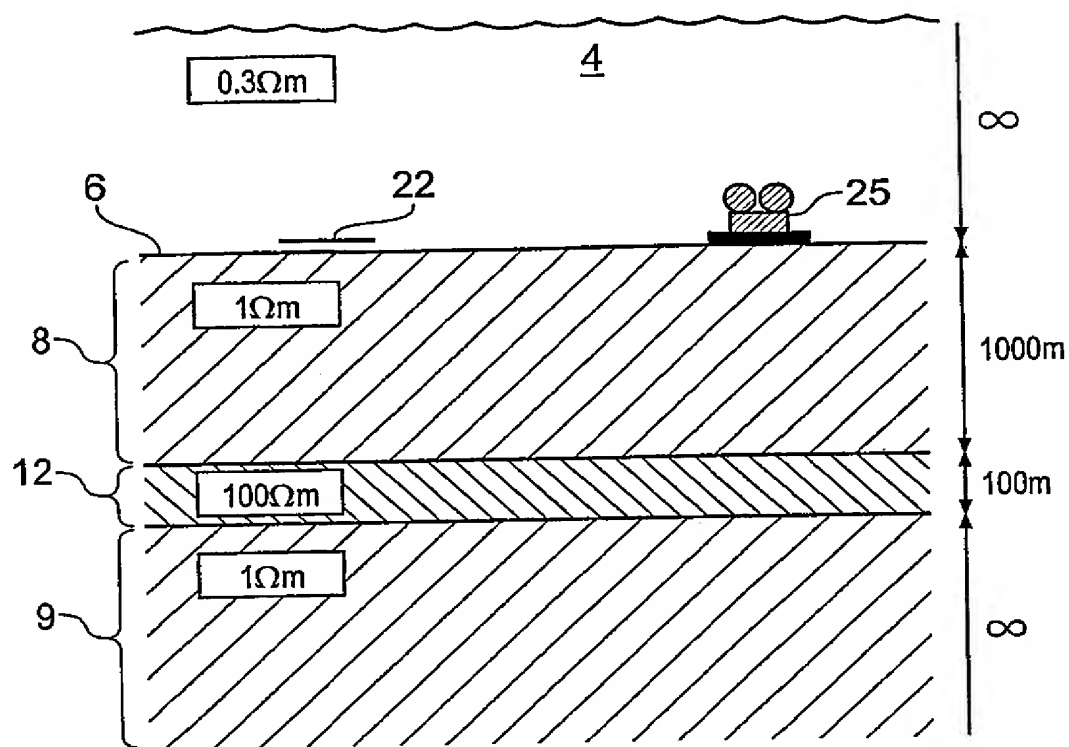
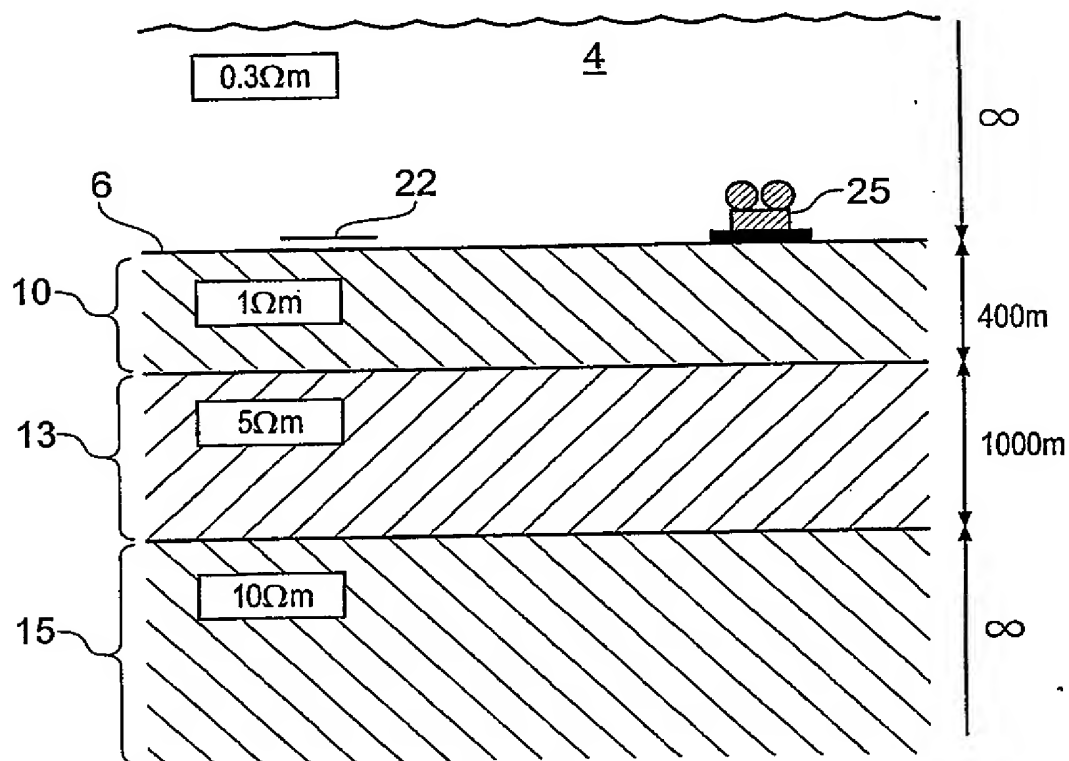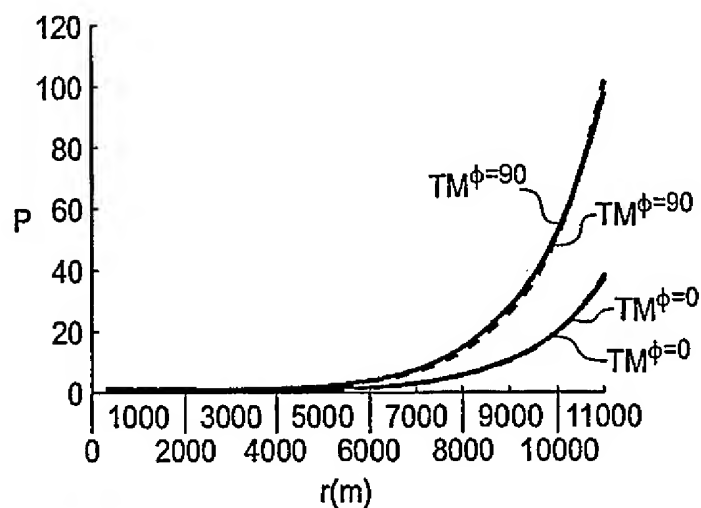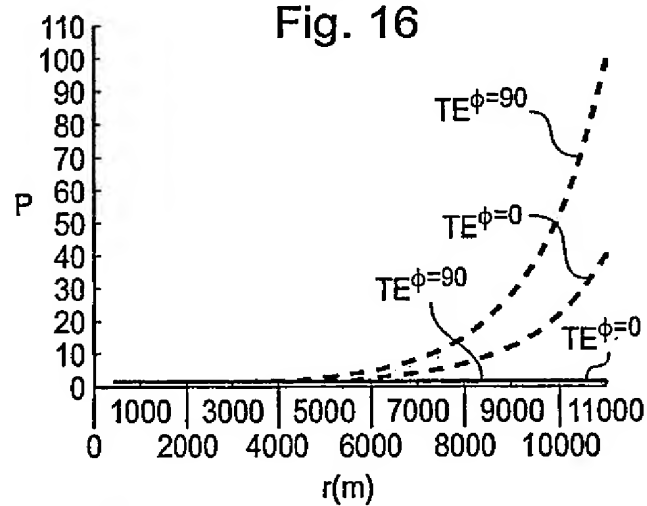### Fig. 15B

Fig. 16

Fig. 18A

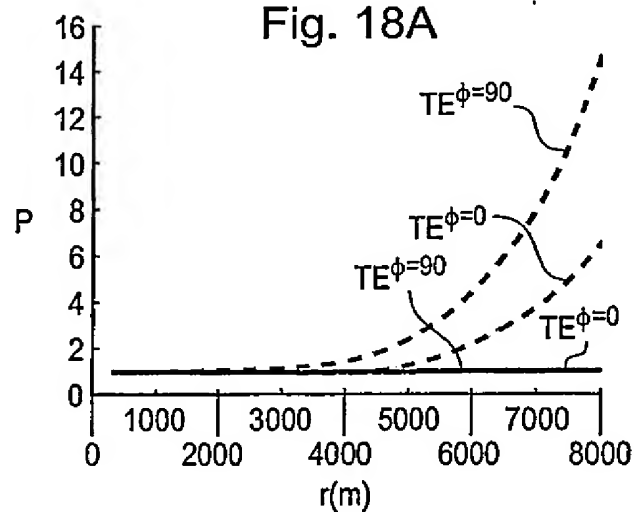Fig. 18B

$$E_r + \frac{\rho_0}{\mu_0}\frac{\partial B_\phi}{\partial z} \;=\; \frac{P\rho_0\cos\phi}{4\pi r}\int_0^\infty \frac{k^2 J_1(kr)}{\beta_0(1 - R_A^{TE}R_L^{TE}e^{-2\beta_0 h})}\Big[e^{-\beta_0|z-z'|} + R_L^{TE}e^{-\beta_0(z+z')} +$$
$$R_A^{TE}e^{\beta_0(z+z'-2h)} + R_A^{TE}R_L^{TE}e^{\beta_0\left(|z-z'|-2h\right)}\Big]\,dk$$

Fig. 17A (EQ.9)

$$E_\phi - \frac{\rho_0}{\mu_0}\frac{\partial B_r}{\partial z} \;=\; -\frac{P\rho_0\sin\phi}{4\pi}\int_0^\infty \frac{k^2}{\beta_0}\frac{kJ_0(kr) - \frac{J_1(kr)}{r}}{1 - R_A^{TE}R_L^{TE}e^{-2\beta_0 h}}\Big[e^{-\beta_0|z-z'|} + R_L^{TE}e^{-\beta_0(z+z')} +$$
$$R_A^{TE}e^{\beta_0(z+z'-2h)} + R_A^{TE}R_L^{TE}e^{\beta_0\left(|z-z'|-2h\right)}\Big]\,dk$$
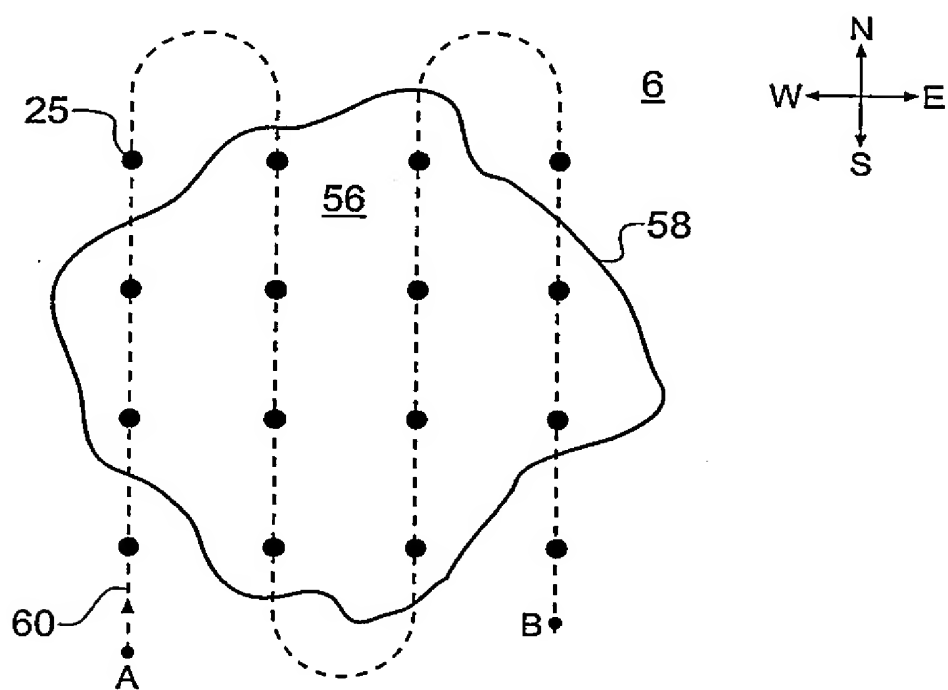
Fig. 17B (EQ.10)

Fig. 19